

ORIGINAL RESEARCH

Evaluation of type 2 Diabetes Mellitus Risk in Patients with post Trauma Splenectomy

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Abstract: Introduction: Recent studies suggest that the spleen has an important role as a source of multipotent stem cells and precursors of beta cells of pancreas islets. In addition, increased risk of developing hyperglycemia was reported in patients who underwent splenectomy due to trauma in long-term follow up. Therefore, there might be an association between splenectomy and an increased risk of type 2 diabetes mellitus. In this study, we evaluated the risk of type 2 diabetes and its risk factors including hyperglycemia, dyslipidemia, obesity and hypertension in trauma patients with splenectomy. Materials and methods: In this study, 221 patients who underwent splenectomy surgery due to trauma in the surgical ward of Imam Hossein Hospital 5 to 10 years ago were selected. Those with a history of diabetes, cancer, hyperthyroidism, Cushing's syndrome, pancreatitis, renal failure, and cirrhosis were excluded from the study. Then fasting plasma glucose, hemoglobin A1c (HbA1c), triglyceride, cholesterol and high density lipoprotein (HDL), body mass index and blood pressure have been evaluated in 90 patients who had had a history of splenectomy due to trauma from 2007, July 23 to 2012, July 22. Results: The results indicate that none of these patients has diabetes, 14.4 percent are in pre-diabetic stage, 56.6 percent has dyslipidemia, 57.7 percent has obesity and 20 percent has hypertension. Conclusion: The results of this study suggest that splenectomy does not increase the risk of type 2 diabetes. Prevalence of diabetes risk factors was approximately the same with those of Tehran population.

Keywords: Diabetes mellitus; Hyperglycemia; Splenectomy; Trauma

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1. Introduction

Diabetes mellitus includes a group of common metabolic disorders, all of which have the hyperglycemic phenotype. The prevalence of the disease has increased dramatically in the past two decades, from about 30 million in 1985 to about

422 million in 2020. Diabetes mellitus is classified into two categories: type 1 diabetes mellitus (T1DM) and type 2 diabetes mellitus (T2DM). T1DM is the result of partial or complete insulin deficiency, and T2DM is a heterogeneous group of disorders characterized by varying degrees of insulin resistance, impaired insulin secretion, and increased glucose production. The abnormal stage of glucose homeostasis before T2DM is classified as impaired fasting glucose (IFG) and impaired glucose tolerance (IGT). (1)

Current criteria for diagnosing diabetes are fasting plasma glucose and hemoglobin A1c tests. Risk factors for T2DM include; family history, obesity (body mass index (BMI) equal to or greater than 25), lack of physical activity, previous diag-

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nosis of IFG or hemoglobin A1c between 5.7 and 6.4, history of gestational diabetes, hypertension, dyslipidemia, Polycystic ovary syndrome and cardiovascular disease. (1)

Glucose homeostasis reflects the balance between hepatic glucose production and peripheral glucose uptake and consumption. Insulin is the most important regulator of this metabolic balance that is produced in the beta cells of the pancreatic islets. (1)

Despite the great importance of the spleen in the immune system and blood circulation, in trauma patients with low blood pressure and a high degree of spleen damage, splenectomy is performed quickly. New evidence suggests that the spleen plays a role as a source of adult multipotent stem cells, which may migrate to the pancreas and become insulin-secreting beta cells. (2-4)

If this hypothesis is correct, it may be necessary to raise awareness to maintain spleen or diabetes mellitus after splenectomy. Research on the role of splenectomy in diabetes mellitus has shown that in animal specimens there is a link between the spleen and the endocrine part of the pancreas (5, 6), and in children and adults there is a link between splenectomy and insulin resistance and other endocrine disorders. (7-12)

The difference between this study and previous studies on the association between splenectomy and diabetes is that in addition to hyperglycemia, we also examined other risk factors for diabetes in the patient population, such as overweight and obesity, hypertension, and dyslipidemia.

Based on the results of recent research cited, in this study we intend to answer the question of whether the long-term risk of T2DM is increased in patients who have undergone splenectomy after trauma. The results of this study are useful in this field, which leads to increased awareness for decision-making to maintain the spleen when it is possible for the patient.

Our hypothesis is that splenectomy increases the risk of T2DM in these patients. To test this hypothesis, 90 patients who underwent trauma at Imam Hossein Hospital 5 to 10 years ago were selected and we will examine the risk factors for diabetes and blood sugar in them.

2. Materials and Methods

To conduct a descriptive study, to evaluate the increased risk of T2DM in patients undergoing splenectomy due to trauma, 221 patients who underwent splenectomy surgery in the surgical ward of Imam Hossein Hospital from 2007, July 23 to 2012, July 22 were selected and evaluated for hyperglycemia, T2DM and risk factors for diabetes and the coexistence of obesity, hypertension and dyslipidemia. Those with a history of diabetes, cancer, hyperthyroidism, Cushing's syndrome, pancreatitis, renal failure, and cirrhosis, were excluded from

the study, the high blood sugar level may be the result of the mentioned illnesses or medications. Also, patients who had any pancreatic damage reported by the surgeon during their abdominal exploration were excluded from the study.

Patients who did not have diabetes or any other significant disease at the time of splenectomy surgery and whose pancreas was not damaged, as well as between the ages of 15 and 50 at the time of surgery, were selected for the study.

Considering the ethical considerations in the research and explaining that according to recent studies, there may be a connection between splenectomy and long-term glycemic control disorder, they were invited to participate in this study. Eventually, 99 people came to the hospital to visit the doctor and perform tests.

To collect patient information, a form was prepared that recorded patient information in three sections: history, examination, and lab tests results. Patients were asked about their history of diabetes symptoms (polyuria, polydipsia, weight changes), family history, dyslipidemia, hypertension, smoking, gestational diabetes, and history of polycystic ovaries. Drugs taken by the patient were also asked, and patients taking hyperglycemic drugs such as beta-blockers, corticosteroids, phenytoin, Diaz oxide, thiazide, and olanzapine were excluded from the study. Patients' body mass index and blood pressure were measured in the examination section. In the lab tests section, fasting blood sugar (FBS), hemoglobin A1C, triglyceride, cholesterol, HDL tests were requested for patients and the results were recorded. Finally, data were collected from 90 patients (38 females and 52 males) who underwent splenectomy after trauma, who were between 20 and 55 years old at the time of the study and did not take the drug that causes hyperglycemia, and were analyzed for data.

SPSS software version 22 was used. Indicators such as standard deviation, mean and mode were examined and recorded separately for each data. T-test was used to examine the relationship between data mean and community mean and probability value was calculated for each variable. The error rate was 5%, which means P-values of 0.05 or less were considered statistically significant.

3. Results

The study looked at 38 women and 52 men between the ages of 20 and 55. The results of this study showed that these people did not develop T2DM in 5 to 10 years after splenectomy, although in 14.4% of people IFG or hemoglobin A1C between 5.7 and 6.4 was observed. And 13 patients were in the pre-diabetes stage. Also, 56.6% of these patients had dyslipidemia. 20% of these patients had hypertension. 57.7% of patients was overweight and obese. There was no history of gestational diabetes mellitus (GDM) and polycystic ovary (PCO) in female patients and there was a family history of di-

abetes in 11.11% of patients.

In the data obtained with SPSS statistical software for each of the variables including: Diastolic blood pressure (DBP), Systolic blood pressure (SBP), body mass index (BMI), high density lipoprotein (HDL), Cholesterol, Triglyceride, HbA1c and FBS; the probable value (P-value) was equal to 0.001. It indicates that the relationship between variables and their mean is strongly related to the mean of the society.

4. Discussion

This study shows that none of the patients who underwent splenectomy had T2DM in 5 to 10 years after surgery. But in 14.4% of patients, there was at least one in two cases of IFG or hemoglobin A1C between 5.7 and 6.4. As a result, it cannot be concluded that splenectomy has increased the prevalence of diabetes mellitus in the long run.

According to the Iranian Lipid and Glucose Study, the prevalence of DM is 14% of people. Every year, 4% of the total adult population of Tehran changes from healthy blood sugar to pre-diabetes, and the incidence of diabetes is 1% of the population in the year. According to the results of the last stage of these studies, the prevalence of pre-diabetes stage is reported to be 14.6%. (13) Animal models of diabetes mellitus suggest a relationship between the spleen and the endocrine part of the pancreas. In one study, avian spleen embryonic cells were used to grow insulin-producing cells, which demonstrates the successful transformation and differentiation of spleen cells into insulin-producing cells and suggests that the spleen could be the ideal source of autologous for transplantation in children who have recently been diagnosed with T1DM. (6)

In one study, children with severe thalassemia who needed a splenectomy were examined who developed insulin resistance(7). In another case, a patient who underwent splenectomy as a child developed endocrine dysfunction, which may be due to the absence of multifocal stem cells(8). It is important to note that the splenectomies studied in these studies were performed in childhood and that the development of the pancreas may be prone to be affected by other diseases after splenectomy. In two adult-specific studies, patients who underwent splenectomy and pancreatectomy for chronic pancreatitis were more likely to develop DM than those who underwent splenectomy. (9, 10)

A study in the California Department of Hospital Surgery examined the association between post-traumatic splenectomy and hyperglycemia in a retrospective review and cohort. In this study, blood glucose in trauma patients with splenectomy who had been followed for at least 5 years was compared with trauma patients who required laparotomy and bowel repair. 9 patients who underwent splenectomy after trauma and were followed for at least 5 years as an experi-

mental group and 12 patients who underwent bowel surgery after trauma and were followed for 5 years as a control group in this study. The mean blood glucose in splenectomy patients was higher than the control group and 4 people in the first group had blood sugar above 130. (11)

In another study, 3,723 patients who underwent splenectomy showed nearly twice as high risk of developing diabetes as those who underwent other abdominal surgeries. (12) The difference between this study and previous studies on the relationship between splenectomy and diabetes is that in addition to hyperglycemia, we also examined other risk factors for T2DM in the patient population, such as overweight and obesity, hypertension and dyslipidemia. Due to limited research time, it was not possible to study patients for a long time. The results of this study may lead to different results in longer follow-up of patients; because, as mentioned earlier, the onset of T2DM is insulin resistance, and over time, in some patients with T2DM for a long time, beta cell mass decreases by nearly 50% in individuals.

It is recommended that a prospective cohort study be performed to investigate the increased risk of developing type 2 diabetes to the stage of insulin dependence in diabetic splenectomy patients and diabetic patients with spleen.

5. Conclusion

This study showed that, contrary to previous studies, in patients who did not have other risk factors for diabetes and their pancreas was not damaged during splenectomy, there was no overall increased risk of T2DM in these patients compared to the general population.

6. Appendix

6.1. Acknowledgment

None.

6.2. Conflict of interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

6.3. Funding and support

None

6.4. Author's contributions

All the authors had the same contribution.

References

1. Jameson JL. Harrison's principles of internal medicine: McGraw-Hill Education; 2018.
2. Faustman DL, Davis M. Stem cells in the spleen: thera-



- peutic potential for Sjogren's syndrome, type I diabetes, and other disorders. *The international journal of biochemistry & cell biology*. 2010;42(10):1576-9.
3. Ryu S, Kodama S, Ryu K, Schoenfeld DA, Faustman DL. Reversal of established autoimmune diabetes by restoration of endogenous β cell function. *The Journal of clinical investigation*. 2001;108(1):63-72.
 4. Kodama S, Kühtreiber W, Fujimura S, Dale EA, Faustman DL. Islet regeneration during the reversal of autoimmune diabetes in NOD mice. *Science*. 2003;302(5648):1223-7.
 5. Yin D, Tao J, Lee DD, Shen J, Hara M, Lopez J, et al. Recovery of islet β -cell function in streptozotocin-induced diabetic mice: an indirect role for the spleen. *Diabetes*. 2006;55(12):3256-63.
 6. Robertson SA, Rowan-Hull AM, Johnson PR. The spleen—a potential source of new islets for transplantation? *Journal of pediatric surgery*. 2008;43(2):274-8.
 7. Lee B, Tan S, Lee W, Yap H, Aw S, Wong H. Glucose tolerance test and insulin levels in children with transfusion-dependent thalassaemia. *Annals of tropical paediatrics*. 1985;5(4):215-8.
 8. Bannerman RM, Keusch G, Kreimer-Birnbaum M, Vance VK, Vaughan S. Thalassaemia intermedia, with iron overload, cardiac failure, diabetes mellitus, hypopituitarism and porphyrinuria. *The American journal of medicine*. 1967;42(3):476-86.
 9. Govil S, Imrie C. Value of splenic preservation during distal pancreatectomy for chronic pancreatitis. *British journal of surgery*. 1999;86(7):895-8.
 10. Hutchins RR, Hart RS, Pacifico M, Bradley NJ, Williamson RC. Long-term results of distal pancreatectomy for chronic pancreatitis in 90 patients. *Annals of surgery*. 2002;236(5):612.
 11. Ley EJ, Singer MB, Clond MA, Johnson T, Bukur M, Chung R, et al. Long-term effect of trauma splenectomy on blood glucose. *Journal of surgical research*. 2012;177(1):152-6.
 12. Wu S-C, Fu C-Y, Muo C-H, Chang Y-J. Splenectomy in trauma patients is associated with an increased risk of postoperative type II diabetes: a nationwide population-based study. *The American Journal of Surgery*. 2014;208(5):811-6.
 13. Azizi F, Madjid M, Rahmani M, Emami H, Mirmiran P, Hadjipour R. Tehran Lipid and Glucose Study (TLGS): rationale and design. *Iranian journal of endocrinology and metabolism*. 2000;2(2):77-86.